Lockheed Aircraft Corporation

CALIFORNIA DIVISION

REPORT NO. SP-123

DATE

COPY NO.

MODEL

TITLE GRANGER ANTENNAS

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GRANGER ANTENNAS

I. INTRODUCTION

The problem of isolating the two antennas sufficiently is a very difficult one. In fact, it may not be possible because of the environment . The specifications call for isolation of 75 db over the range of 8.2 to 11.0 KMC. Seventy-five decibels of isolation means that only 3 millionths of one percent of the energy leaving the transmitting antenna will reach the detector. It is entirely possible that energy reflected from the exhaust gases will be greater than the desired minimum.

Measurement of such ratios as 100 million-to-one is a difficult task and an unusual method had to be employed. By suitable means, however, isolation of more than 80 db (1 millionth of one percent) was measured.

II. DESCRIPTION OF THE TEST METHOD

The test method employed was as follows:
The coupling between the antennas was reduced to such an extent that the coupled power was less than the noise level of the receiver when the antennas were looking at free space. This was accomplished by the use of a creeping wave attenuator and a lossy septum. Rough measurements using two Hewlett-Packard X832 microwave precision attenuators indicated at least 70 db of isolation. (No attempt was made to account for wave guide-to-coax. mismatch losses or for coax. losses).

II. DESCRIPTION OF THE TEST METHOD (cont)

At this point a completely different method of measurement was employed. Consider what happens if two coherent signals are combined in a suitable mixer. If the phase of one signal can be varied so that the signals can be combined in phase or out of phase the ratio of the magnitude of the signals easily can be determined.

This scheme was implemented in the following way. A highly conducting sphere was supported in free space at a known distance from the antenna assembly (with the radome and decoupling devices in place).

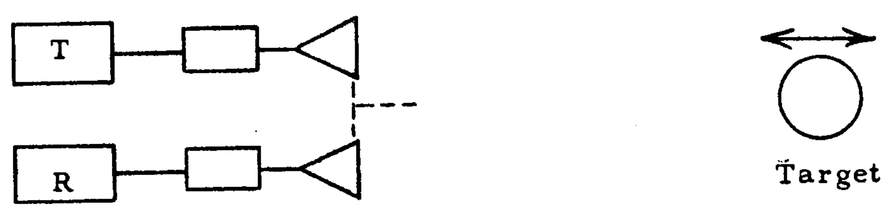

Figure 1 - Schematic, moving target method of measuring cross-coupling.

The sphere was then caused to move forth and back along the center line of the system and the ratio of $P_{max.}$ to $P_{min.}$ was recorded. The test was performed at two different separations; 5 feet and 7 feet.

While the sphere was moving, the total field varied between the limits indicated by eq. (1)

$$E_t = E_c \pm \sqrt{\frac{P_t \; G^2 \; \lambda^2 \sigma}{(4\pi)^3 \; R^4}} \qquad E_c \pm \sqrt{M} \tag{1}$$

The P. S. W. R. is (see para. III for symbol definitions)

$$\frac{P_{max.}}{P_{min.}} = \rho^2 = \left(\frac{\sqrt{M} + E_c}{\sqrt{M} - E_c} \right)^2 \tag{2}$$

III. RESULTS OF MEASUREMENTS

Define the total attenuation (decoupling) as:

$$\alpha_t = \alpha_s + \Delta$$

α_s = spherical spreading loss

Δ = "moving target" correction

The loss, α_s, caused by spherical spreading of the waves over the range R, is:

$$\alpha_s = \frac{P_t}{P_r} = \frac{(4\pi)^3 R^4}{G^2 \lambda^2 \sigma}$$

P_t = transmitted power

P_r = received power

R = separation between the target and the receiver

G = radiation pattern gain

λ = wavelength

σ = target "echo area"

For: R = 7 ft. = 213.3 cm.
G = 10
λ = 3 cm.
σ = 182 cm^2 (6" dia. sphere)

$$\alpha_s = 1.996 \times 10^7 \text{ (73 db)}$$

The variation caused by moving the target was:

$$(P_{max} - P_{min})_{db} = 3.0 \text{ db}$$

III. RESULTS OF MEASUREMENTS (cont)

From Figure 2, the correction, Δ db, is 15.5 db. Therefore, the total attenuation is:

$$\alpha_t = 73 + 15.5 = \underline{88.5 \text{ db}}.$$

For: $R = 5 \text{ ft.} = 152.5 \text{ cm.}$

$G = 10$

$\lambda = 3 \text{ cm.}$

$\sigma = 182 \text{ cm}^2$ (6" dia. sphere)

$\alpha_s = 68.2 \text{ db.}$

The variation caused by the moving target was:

$$(P_{max.} - P_{min.}) \text{ db} = 1.5$$

The correction, from Figure 2 is:

$$\Delta \text{ db} = 21.4 \text{ db.}$$

Therefore, the total attenuation is:

$$\alpha_t = 68.2 + 21.4 = \underline{89.6 \text{ db.}}$$

This figure, 88→89 db, represents approximately one <u>10 millionth of 1 percent</u> of the transmitted energy reaching the receiver. It certainly does not appear practical to attempt to decrease this!

Figure 3 shows the effect of antenna gain on the spreading loss. The measured absolute gain of the antennas used in this test averaged about 7.5 db for 3 cm. wavelength.

Figure 2

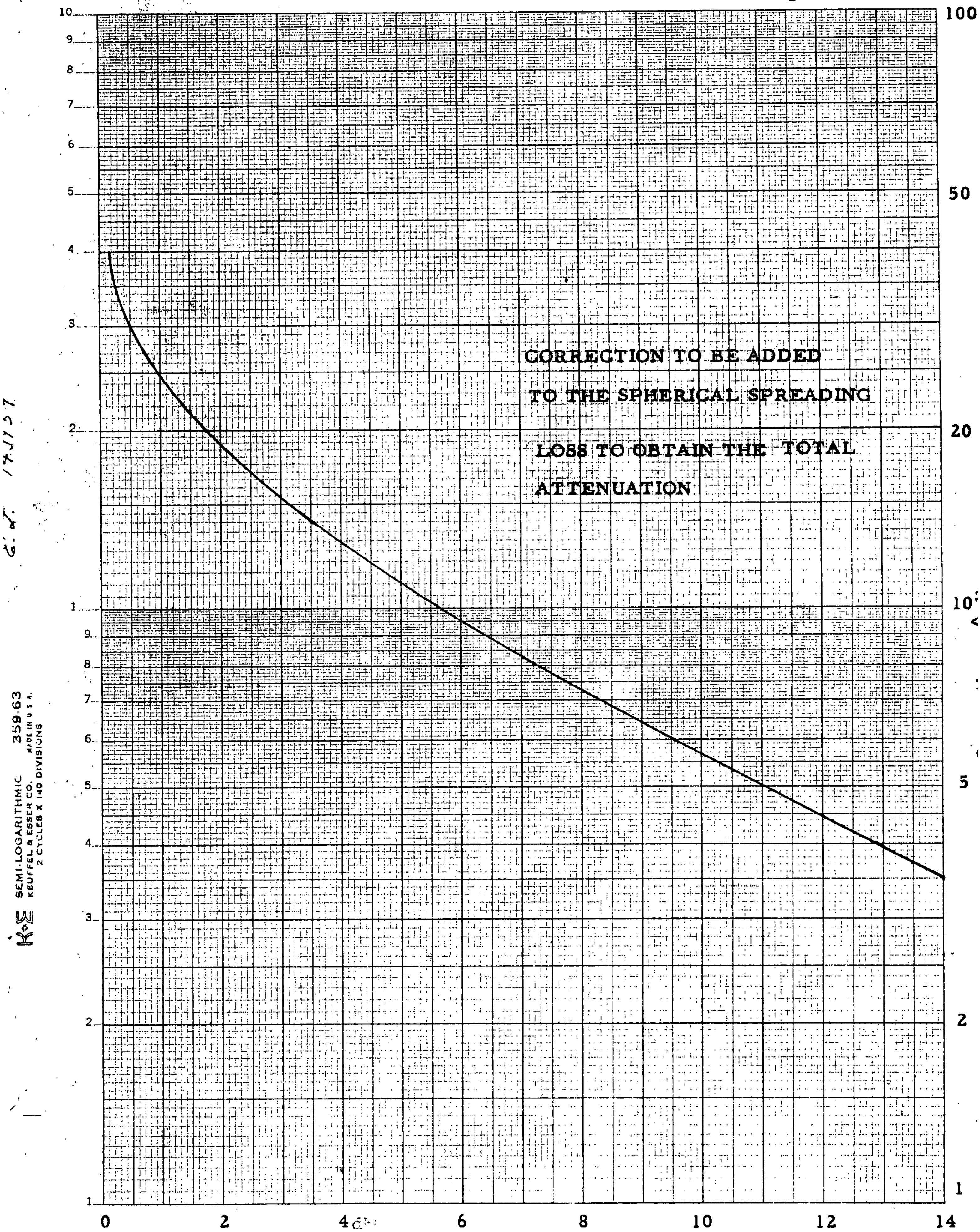
CORRECTION TO BE ADDED
TO THE SPHERICAL SPREADING
LOSS TO OBTAIN THE TOTAL
ATTENUATION
100
50
20
10
5
2
1
0
2
4
6
8
10
12
14
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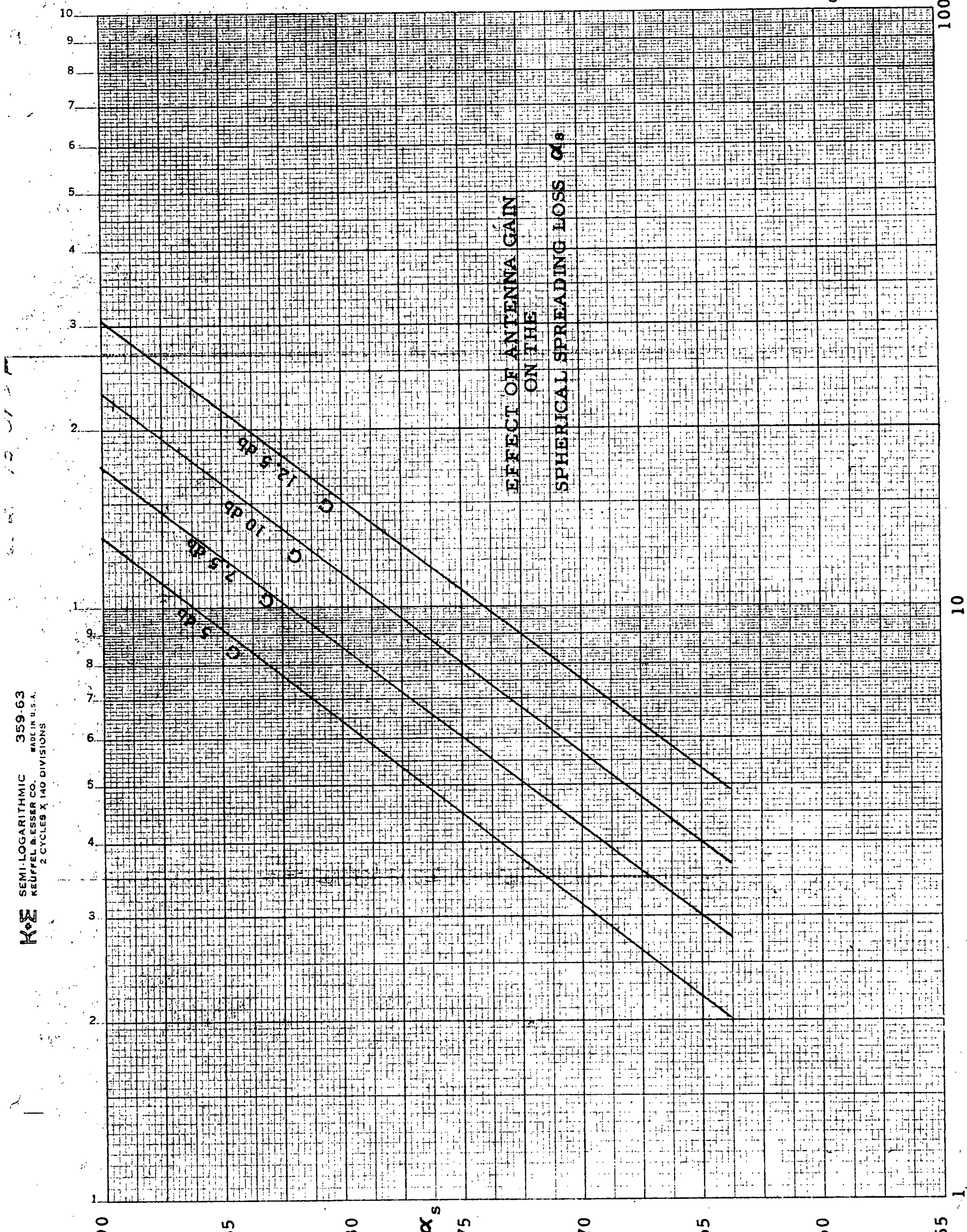
Figure 3


EFFECT OF ANTENNA GAIN
ON THE
SPHERICAL SPREADING LOSS α_s
G 12.5 db
G 10 db
G 7.5 db
G 5 db
R Feet
α_s
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